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Applicability of an Agro-hydrological Model (SMCR_N) in Simulating the Yield and Nitrate Dynamics of Eggplant in North China Plain

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Abstract

SMCR_N is a recently developed sophisticated model which simulates crop response to nitrogen fertilizer for a wide range of crops, and the associated leaching of nitrate from arable soils. The objective of this study was to investigate the possibility of using SMCR_N model as a research tool to investigate interactions between the amount and timing of N application and effects on vegetable production and environmental impact. In this paper, we used data from 16 field plot experiments to carry out the model calibration and found out that the simulated values of crop dry weight were strongly correlated with the measured values throughout growth in all the experiments with a R^2 of 0.9248. Then we choose the field plot 1 to carry out the model validation. The simulated soil mineral N concentration was less satisfactory, although statistically the simulated values of soil mineral N concentration were still correlated fairly well with the measured values (R^2 = 0.766). This indicate that the model has the potential to optimize N use and assess the impact of N leaching in eggplant production under the temperate continental monsoon climate of the North China Plain.

Keywords:model, eggplant, yield, soil mineral N, North China Plain

1. Introduction

Agro-hydrological models have proved to be useful tools in optimizing irrigation scheduling and fertilizer application, and in assessing the impact of different farming practices on the environment. Numerous models have been reported for these purposes in the literature in the last few decades [9,1,15,5, 8,3,11,10,13,14,12]

Many of agro-hydrological models are devoted to assessing the effects of nitrogen (N) fertilizer on crop

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growth and N leaching for various crop species[4]. The most prominent models that cover a range of crops are the EPIC models[15] and the DSSAT models[8]. Although the EPIC and DSSAT models have proved useful in both basic and applied studies of the effects of climate and management on growth and the environment, the models are generally crop specific, and require parameter values which are difficult to determine for a given crop.

SMCR_N model, which is based on a version of N_ABLE[7], has been developed for crop N response and N leaching in arable soils[17]. The model covers a wide range of crops, which makes it a good candidate for forecasting both optimum N inputs and the environmental consequences of crop production.

The aim of the study was to validate the SMCR-N model against the data from the Shunyi Science Base to access the ability of the model in predicting N dynamic and crop yield in eggplant production under the temperate continental monsoon climate of the North China Plain.

2. Materials and metheds

2.1 SMCR_N model

The inputs for running the SMCR_N model include site characteristics, weather data, soil properties, fertilization and irrigation and cropping parameters together with the initial conditions[17].

2.2 Experimental data

Measured data sets from field experiments from Shunyi District, Beijing City, China were used for model validation. A site description is given in Table 1. The SMCR_N model was tested using field measurements from 16 treatments at one location (Unpublished data).

Table 1. Experimental sites used for simulation-observation comparisons

Location	Latitude (°N)	Longitude (°W)	Soil type	Precipitation (mm)
Shunyi	116.9	40.1	sandy loam	480.6

Table 2. Soil's background geochemical values of the experiment field

Soil Layer (cm)	pH	OM(%)	NO_3^--N	Available P	Available K
0-20	8.38	1.262	8.6	31.57	72
20-40	8.53	0.357	3.8	4.24	32
40-60	8.59	0.344	2.6	2.08	30
60-80	8.48	0.416	1.6	3.26	36
80-100	8.72	0.683	1.9	2.47	52

2.3 Weather data

Daily data for sunshine hours, maximum and minimum temperature and precipitation from Shunyi of the year 2009 were made available by the Weather Station of Shunyi District. Fig. 1 presents summarized average monthly weather data of Shunyi.

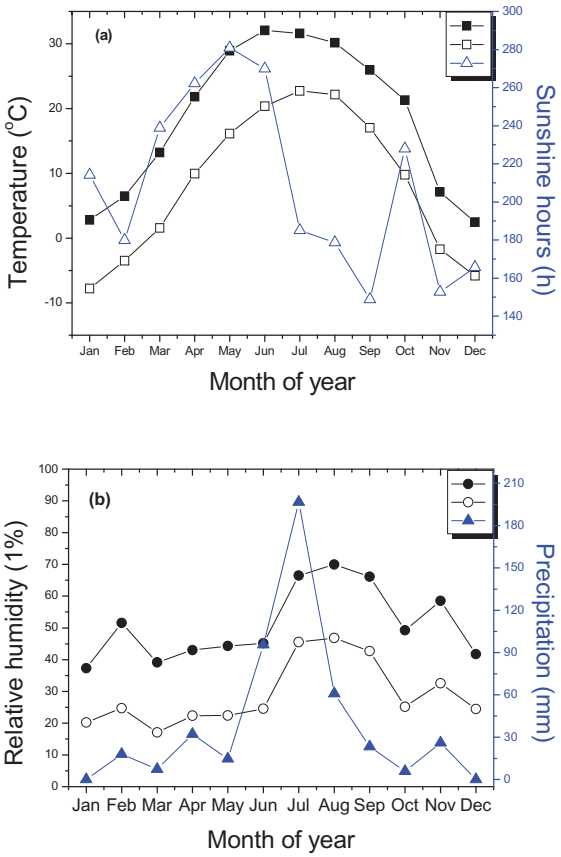

Fig. 1. Average monthly sunshine hours (Δ), maximum (■) and minimum (□) temperature(a), and Precipitation (▲), average humidity (●) and minimum humidity (○)(b) are based on weather data of Shunyi (2009).

3. Results and discussion

The simulated values of crop dry weight were strongly correlated with the measured values throughout growth in all the 16 field plots experiments (Fig. 2). Regressions of simulated and measured values gave high R^2 of 0.9248 to the dry weight, indicating that the model is capable of reproducing the measured values well.

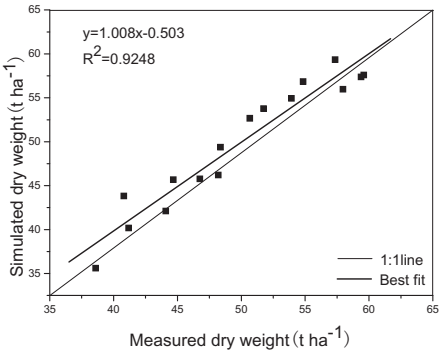

Fig. 2. Comparison of dry matter of the selected 16 field plots between measurement and simulation

The result of simulating soil mineral N concentration was less satisfactory (Fig. 3), although statistically the simulated values of soil mineral N concentration were still correlated fairly well with the measured values (R^2 = 0.766). This indicate that the model has the potential to optimize N use in eggplant production under the temperate continental monsoon climate of the North China Plain.

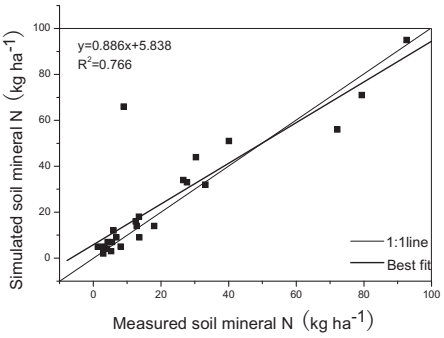

Fig. 3. Comparison of soil mineral N of field plot 1 between measurement and simulation

4. Conclusion

From this comprehensive set of model–observation comparisons, it is concluded that the SMCR-N model is capable of reproducing the measured data. The simulated results agree well with the measured values, indicating that the model has the potential to optimize water and N use and assess the impact of N leaching from different management strategies in eggplant production under the temperate continental monsoon climate of the North China Plain. The SMCR-N model can thus be used as a research tool to investigate interactions between the amount and timing of N application and effects on vegetable production and environmental impact.

5. Acknowledgements

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